ET42

ELECTRICAL WORKERS
REGISTRATION BOARD
Safety • Competency

Candidate Code No.

For Board Use Only

Result	Result
Date	Date
Int	Int

ELECTRICIAN'S THEORY EXAMINATION

23 June 2012

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.

(turn over)

Question 1

(a) State **TWO** factors which affect the severity of electric shock upon the human body.

(2 marks)

(1) ____

(2) ____

(b) A Class I, plug-in heater is designed for use on 230V/240V a.c. supply. An ohmmeter gives a reading of 24 ohms measured at the plug.

Use calculations to show the supply voltage being used if the power dissipated is 2204W.

(2 marks)

(c) A single-phase, fixed-wired appliance that has been operating normally is to be disconnected for maintenance

An isolating switch near the appliance has been turned off. When testing for isolation at the **appliance terminals** it is found the terminals were live.

State **TWO** possible causes for this situation.

(2 marks)

(1) ____

____

(2) ____

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(turn over)

Question 1 continued

(d) A three-phase hoist has been **operating normally**. A new three-phase supply has been installed to the hoist isolator.

After the new supply was installed, voltage testing on the supply side of the isolator showed that the phases were connected to the phase terminals, the neutral to the neutral terminal and earth to the earth terminal.

When the isolator is turned on the hoist would not start. Explain why the hoist would not start.

(2 marks)

(e) The output circuit of an autotransformer **must be** insulated for the highest input or output voltage of the autotransformer.

State **ONE** reason for this requirement.

(2 marks)

(f) Explain the term **sensitivity** in relation to an RCD.

(2 marks)

(turn over)

Question 1 continued

(g) A test instrument is being used to confirm the isolation of a 230V circuit (that may or may not be live). The test instrument is in good condition and suitable for the purpose.

State the main action that should be taken prior to commencing the test for isolation.

(2 marks)

(h) (i) State **ONE** device that can be used instead of a centrifugal switch in a single-phase capacitor-start motor.

(1 mark)

(ii) Describe how the direction of rotation is reversed in a single-phase, capacitor-start, capacitor-run motor.

(1 mark)

(i) Every electrical installation has a prospective-short-circuit current rating.

State **TWO** reasons why it is important to consider the prospective-short-circuit current rating when selecting a protective device for an electrical installation.

(2 marks)

(1) __________

(2) __________

(turn over)

Question 1 continued

(j) What is meant by the term **inverse time-current characteristic** in relation to protective devices?

(2 marks)

(turn over)

Question 2

Introduction

A three-phase star-connected commercial oven draws 32A from a 400V supply and is protected by 40A gG HRC fuses with a utilisation category (fusing factor) of 1.5.

Use the information in the introduction to answer parts (a) and (b).

(a) An earth fault loop impedance test for the oven shows a reading of 0.38Ω.

While the oven was operating, a fault of 5.6Ω has developed between the blue phase and the oven frame.

(i) Calculate the total current flowing in the faulty blue phase.

(3 marks)

(ii) Explain, using calculations, the effect on the operation of the fuse.

(1 mark)

(turn over)

Question 2 continued

(b) **On another occasion**, the earth fault loop impedance for the oven was 4.84Ω due to a high resistance joint

While the oven was operating, a fault of 5.6Ω has developed between the white phase and the oven frame.

(i) Calculate the total current flowing in the faulty white phase.

(3 marks)

(ii) Explain, using calculations, the electrical hazard to the user of the oven.

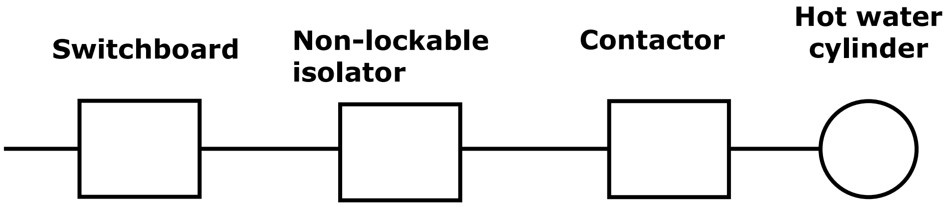
(3 marks)

(turn over)

Question 3

Introduction

The following figure is a block diagram of a three-phase circuit to a three-phase **star-connected** hot water cylinder in a factory. There are no other connections to the circuit.



The cylinder circuit is protected by HRC fuses on a three-phase switchboard and the non-lockable isolator and contactor are adjacent to the cylinder.

The existing hot water cylinder is to be replaced. The new cylinder will be installed at a later date

Use the information in the introduction to this question to answer parts (a) and (b).

Question 3 continued

(a) You have been requested to:

- Disconnect the wiring from the existing cylinder.
- Leave the wiring in place to allow connection of the new cylinder.
- Ensure that the area is safe to leave unattended.

(i) ***__Before disconnection takes place__***, describe how you will isolate the cylinder and wiring to ensure it is safe to disconnect.

(3 marks)

(ii) **__After disconnection has taken place__**, what would you do to ensure that:

- The wiring can be connected to the new cylinder at a later date.
- The work area is safe to be left unattended.

(2½ marks)

(turn over)

Question 3 continued

(b) Sometime later, another electrician is engaged to connect the new cylinder.

(i) State the **first** action that electrician should take before attempting to connect the new hot water cylinder.

(1 mark)

(ii) The electrician has a multi-function test instrument that has voltage; amperes; resistance; insulation resistance; frequency; capacitance; and temperature functions.

An instrument test needs to be carried out on the cylinder to ensure it is safe to connect to the electricity supply. For that test state:

- The name of the test.
- The function and range selected on the test instrument
- How the test is carried out.
- A test result that will permit the cylinder to be connected.

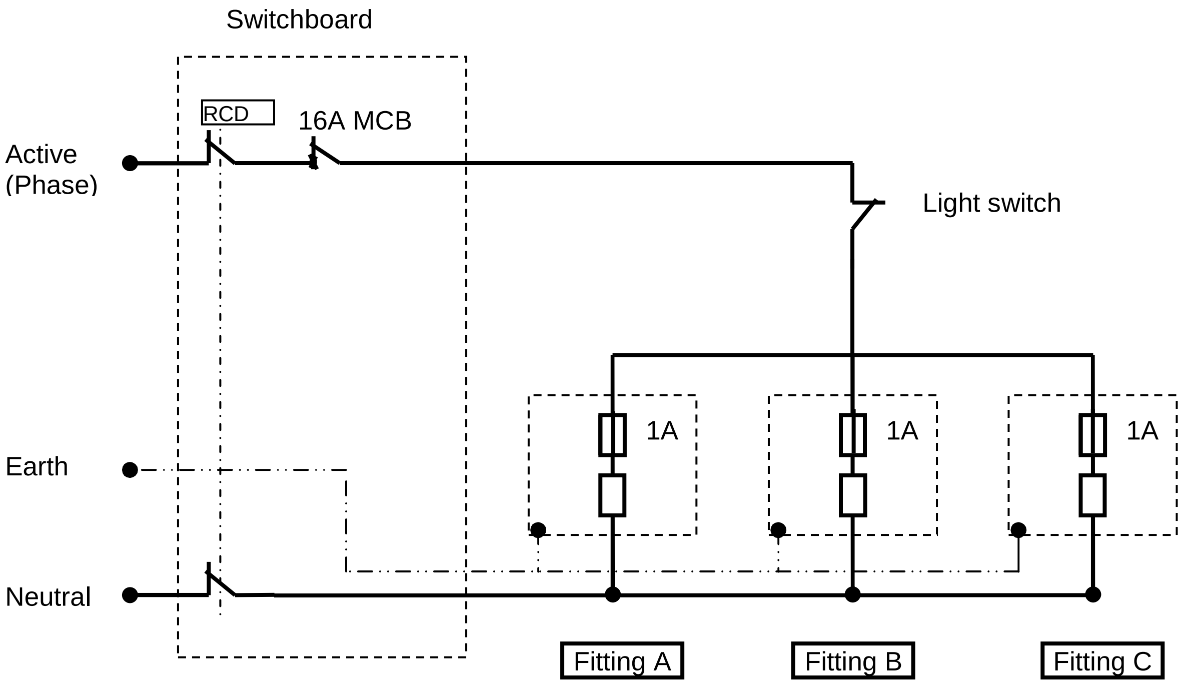
(3½ marks)

(turn over)

Question 4

Introduction

The figure below represents 3, 230V single fluorescent lights in one section of a factory. This circuit is supplied from a three-phase switchboard



The fuses in the light fittings are HRC fuses.

Use the information in the introduction to this question to answer parts (a), (b) and (c)

(a) The section of the factory incorporates rotating machinery.

The main reason why the fluorescent lighting is not suitable is **stroboscopic effect.**

(i) Explain how a fluorescent light produces a **stroboscopic effect.** (2 marks)

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(turn over)

Question 4

(ii) Describe the dangers produced by **stroboscopic effect**.

(2 marks)

(iii) State **TWO** methods of eliminating **stroboscopic effect**.

(2 marks)

(1)

(1)

(b) How is discrimination achieved in the lighting final subcircuit.

(2 marks)

(c) State the **main reason** why the fuses in the light fittings must not be shorted out or increased in current rating.

(2 marks)

(turn over)

Question 5

Introduction

An existing 230V domestic electrical installation has been completely rewired. No change was made to the mains and main earthing system

The work included a new switchboard with RCCB and MCB protection and all final sub-circuits including a 2 kW water heater and a 6 kW range. Both the water heater and range incorporate **MIMS elements**.

You need to carry out an insulation resistance test on the installation (but not the mains or main earthing system). **The installation is isolated at the main switch**.

Use the information in the introduction to answer parts (a) and (b).

(a) You are going to carry out an insulation resistance test of the entire electrical installation **without disconnecting any final subcircuits**.

(i) State the **THREE** actions you will take before carrying out the insulation resistance test.

(3 marks)

(1) ______________________________

(2) ______________________________

(3) ______________________________

(ii) Describe how you will carry out the insulation resistance test on the entire installation.

(1 mark)

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(turn over)

Question 5 continued

(b) Your insulation resistance test of the entire electrical installation produced a test result of **0.1MΩ**.

Describe the actions you will take to confirm that the test result you have obtained allows the electrical installation to certified on a certificate of compliance.

In the description state any acceptable test results.

(6 marks)

(turn over)

Question 6

Introduction

A three-phase motor is controlled by DOL starter that contains thermal overloads. The starter control circuit operates at **230V**. The motor circuit is protected by HRC fuses.

Use the information in the introduction to answer parts (a), (b) and (c).

(a) (i) Draw and label the circuit diagram of the **230V** DOL starter control circuit. The control circuit incorporates electrical protection.

You do not need to show the main contacts or the motor

(4 marks)

(turn over)

Question 6 continued

(ii) The 230V coil in the control circuit has burnt out. The only replacement you have is a 400V coil. State the modifications you would make to the 230V control circuit so the 400V coil can be used.

(2 marks)

(b) The thermal overload protection is replaced with thermistor protection.

Describe how the thermistor would provide protection to the motor

(2 marks)

(c) When the start button is pushed on the DOL starter the contactor closes, but as soon as the start button is released the contactor drops out.

State the main reason why this situation would occur.

(2 marks)

(turn over)

Question 7

Introduction

A 230V, Class I, kiln is supplied by a circuit that has RCCB and MCB protection at the switchboard.

The kiln is sitting on the tiled section of a wooden floor.

Use the information in the introduction to answer parts (a), (b) and (c).

(a) The kiln isolator has been replaced. During the work the **phase and neutral** were accidentally transposed at the **supply side** of the isolating switch. When the isolating switch was turned on:

(i) What effect would this transposition have on the operation of the kiln?
(1 mark)

(ii) What effect would this transposition have on the operation of the protective devices under fault conditions?
(1 mark)

(iii) What potential danger would this transposition create?
(2 marks)

(turn over)

Question 7 continued

(b) The kiln isolator has been replaced. During the work the **neutral and earth** were accidentally transposed at the **supply side** of the isolating switch.

State what would occur when the isolating switch was turned on.

(1 mark)

(c) The kiln isolator has been replaced. During the work the **phase and earth** were accidentally transposed at the **supply side** of the isolating switch. When the isolating switch was turned on:

(i) What effect would this transposition have on the operation of the kiln?

(1 mark)

(ii) What effect would this transposition have on the operation of the protective devices under fault conditions?

(2 marks)

(iii) What danger would this transposition create?

(2 marks)

(turn over)

Question 8

(a) (i) Draw and label a figure that represents a three-phase supply from a 230/400V MEN distribution system to a consumer's installation. Include:

- The MEN main earthing system
- The consumers neutral and earth bars and main earthing system.
- A final sub-circuit MCB for one of the three phases.
- A fixed-wired Class I electrical appliance connected to a single-phase final subcircuit. The appliance has a phase to frame fault on the load side of the appliance switch.

You do not need to show the main switch or metering

(4 marks)

(ii) Clearly indicate on the figure, the earth fault path for the faulty appliance circuit.

(1 mark)

(turn over)

Question 8 continued

(b) State the main reason why the overall impedance of an earth fault loop must be low.

(2 marks)

(c) An earth loop impedance test result of 0.32Ω has been recorded on a 230V final subcircuit supplying socket outlets in a low voltage electrical installation.

Calculate the fault current that will flow if a short circuit occurs on the final subcircuit.

(2 marks)

(d) A MEN, low voltage domestic installation is required to have a main earthing conductor.

(i) To which parts of the electrical installation are the ends of the main earthing conductor connected?

(½ mark)

(ii) What is required to be attached at one end of the main earthing conductor?

(½ mark)

(turn over)

Question 9

(a) **Introduction**

A 250 kVA, three-phase, delta-star-connected step-down transformer has a phase- turns ratio of 287 to 1. The primary is connected to a 66 kV, three-phase supply, and the transformer is fully loaded.

(i) Calculate the **secondary phase** voltage.

(2 marks)

(ii) Calculate the **secondary line** voltage.

(2 marks)

(iii) Calculate the **primary line** current.

(2 marks)

(turn over)

Question 9 continued

(iv) Calculate the **secondary line** current.

(2 marks)

(b) State **ONE** reason why a current transformer is dangerous when its secondary winding is left in the open circuit condition.

(1 mark)

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(c) State **ONE** practical method used to reduce the iron loss of a transformer when it is constructed.

(1 mark)

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In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

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Questions Answered	**Marks**	
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